Some question may be raised, perhaps, as to the legitimacy of the assumption of such a phylogenetic origin of *Paradoxides*. The most diagnostic character of the entire family *Mesonacidae* is the absence of a facial suture, although well-developed compound eyes are present. Elsewhere among the trilobites, where the free and fixed cheeks have become anchylosed, with the consequent disappearance of the facial suture, as, for instance, in the Devonian genus *Phacops*, this character has appeared at the termination of a long phylogenetic line in which all the earlier members possess functional facial sutures. The facial suture is so characteristic of every order and every family of trilobites, save the *Mesonacidae*, that one is forced to the assumption that it was a character of the primitive stock from which all have sprung. It therefore seems necessary to assume that the ancestors of the *Mesonacidae* possessed a functional facial suture, and that the absence of this character in this group of genera is indicative of its terminal position in a long phylogenetic line whose pre-Cambrian history is unknown to us. Since such a character when once lost cannot be restored again, it would follow that *Paradoxides* with its functional facial suture could not have originated from any member of the *Mesonacidae*. Might it not be assumed that *Paradoxides* arose from a totally distinct phylogenetic line in a different early Cambrian biologic province, perhaps southern Europe, and later migrated into the North Atlantic province where it occurs in strata generally younger than those bearing the Mesonacid faunas? Under such an interpretation it would be necessary to grant that somewhere *Paradoxides* may have been contemporaneous with at least a portion of the Mesonacid faunas in North America, and this contemporaneity may even have extended to the North American shore of the North Atlantic basin.

The paper adds much to our knowledge of these very ancient faunas of the earth, and the author is to be congratulated upon the success of his most persistent search for these rare fossil forms. Not the least attractive portion of the paper are the twenty-two beautifully executed half-tone plates.

S. W.

Elements of Geology. By ELIOT BLACKWELDER AND HARLAN H. BARROWS. Pp. 475; figs. 485; pls. 16. New York: American Book Co., 1911.

This is not a manual or reference book, but an elementary textbook intended primarily for use by young students in the high schools, acade-

mies, and institutions of similar grade. The book was written in the belief that it is the function of a text as well as the duty of a teacher to develop in the student the power to reason. This spirit pervades the work throughout.

The method is essentially analytical and the text explanatory rather than descriptive. Abundant use is made of questions which are ingeniously devised to guide the student's mental operations and to lead him unconsciously through certain desired chains of reasoning. Many of the questions are inserted in the text—a practice which makes the student stop and think and, by causing him to tie his ideas together, incidentally and unconsciously brings him to see the interrelation of the different geologic agents and processes.

The treatment throughout indicates a continuous desire to prevent the student from forming hard-and-fast conceptions of processes and geologic features that are necessarily often variable. There is a steady determination to compel the student to maintain a critical open mind and at the same time to draw close distinctions in the use of variable terms, as in the relative heights of hills and mountains and of plains and plateaus. Sometimes, however, this most laudable endeavor threatens to overstep itself and lumber up the text with hypercritical qualifications. In an elementary textbook where space is severely limited unessential discriminations crowd out more weighty matter, while the student on his part may come to give too much thought to precision in little things at the expense of a grasp of great things. But this is only another item in the ever-present question of where to draw the line.

The text is clear, direct, and well written. In some cases, as in chap. i, the opening paragraph is a bit wobbly, but when the initial groping for just the right line is past and the topic is well under way, the chain of ideas, like the language, flows evenly and gracefully along without effort.

Poise and balance characterize the treatment of facts and principles. The essential features are treated clearly though concisely, and the minor features are subordinated or left out where their omission does not weaken the presentation of the main topics. Unessential facts have been carefully pruned. Keen discrimination is apparent here.

The departure of the authors from current practice in the arrangement of material will be most conspicuously seen in the omission of separate chapters on vulcanism and earthquakes. This was done in the belief that volcanoes and especially earthquakes are exceptional

and local phenomena and that although spectacular and ever interesting to the popular mind, they are not entitled to the same space in such a work as are the more general geologic processes. The main features of vulcanism and volcanic rocks are, however, quite adequately treated in the chapter on the composition of the earth, while volcanic mountains as surface features appear in the very excellent chapter entitled "The Great Relief Features of the Land."

The proper handling of historical geology in brief space is a difficult task. There is a great deal of ground to be covered and a great mass of material to be judiciously picked over. Unless the work is well done, the residue left is apt to be a dry bone skeleton with the flesh and blood largely gone. In the historical portion of this work the salient and vital points are made to stand out clearly. This is particularly true of the life history. In part this is secured by a sprightly use of paragraph headings to feature the various vicissitudes through which life forms have passed in their long history. With these in mind, the significance of the discussion is more readily grasped and the details are more easily retained.

The authors have treated the Tertiary as a "Period," giving it the same rank in the geologic time scale as they do the Comanche or the Cretaceous. After stating that it is divided into the Eocene, Miocene, and Pliocene epochs, the Tertiary is discussed largely as a unit. The Tertiary presents many rich problems for advanced students, especially its mammalian evolution and its diastrophism, but these are perhaps beyond the reach of a beginning class. The authors, believing that the points of newness or striking facts are largely over by the time the Tertiary is reached, have apparently thought it best to curtail the treatment and advance rapidly to the close of the history.

A feature which cannot be too highly commended is the extensive use of three-dimension diagrams to portray the operation of geologic processes. This, in the reviewer's opinion, is much more expressive than the ordinary style. The set of three block diagrams on p. 146 which picture the successive development of youthful, mature, and old topography, illustrating not only the surface development of the streams but the simultaneous lowering of the land toward peneplanation, shows the possibilities of the method.

By reducing the size of the illustrations, a very large number have been successfully introduced and add very greatly to the effectiveness and attractiveness of the book. It is a veritable picture book with most of the pictures new to geologic readers.

Finally it may be said that the general scheme and mode of treatment of the book follow the lead of the comprehensive treatise of Chamberlin and Salisbury, and the fundamental views which give distinctive character to that work find reflection in this.

R. T. C.

Geology of the Kiruna District (2). Igneous Rocks and Iron Ore of Kürunavaara Luossovaara and Tualluvaara. Academical Dissertation by PER A. GEIJER, for the degree of Doctor of Philosophy. By the permission of the philosophical faculty of the University of Upsala. Stockholm, 1910. Pp. 278; 2 geologic maps.

The district is in northern Lapland. The rocks, which are generally regarded as pre-Cambrian, include greenstones, conglomerates, syenite porphyries, magnetite ores, quartz porphyry, phyllites, sandstones, etc. They are strongly folded and in general stand nearly vertical but otherwise do not show pronounced metamorphism. The textures are well preserved. A typical ore body is the one of Kürunavaara which forms the backbone of a mountain about 748 meters high. This ore body is over 5 kilometers long and some 96 meters wide. Other ore bodies are somewhat smaller. The ore zone is included between quartz porphyry and syenite porphyry. The minerals of the ore are magnetite, hematite (subordinate), fluor-apatite, augite, amphibole, biotite, titanite, tourmaline, zircon, etc. Generally there is enough apatite to place the ore above the Bessemer limit.

The ore minerals are intergrown like those of an igneous rock and contacts between ore and country rock are in places gradational. All of the minerals of the ore except tourmaline are primary constituents of igneous rocks near by. Rock textures indicate that the ore mass has crystallized quite in the same way as an igneous rock—these include trachytoidal flow structure, skeleton forms of magnetite, and the ophitic distribution of augite. The ores are believed to be of magmatic origin and the writer is inclined to the view that the associated syenites are effusive in character. He does not agree with De Launey, who held that the ores were deposited at the surface from gases and hot solutions by pneumatolytic-sedimentary processes. The writer does not feel sure as to the nature of the differentiation processes which have resulted in the product, but does believe that such an origin is proven.

W. H. E.